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(54) **METHOD OF PRODUCING BLEACHED THERMOMECHANICAL PULP (TMP) OR BLEACHED CHEMITHERMOMECHANICAL PULP (CTMP)**

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(57) **ABSTRACT**

There is a need for a cheaper method of producing bleached TMP and CTMP without impairing the properties of the pulp. This is made possible by the present invention, which relates to a method of producing said pulps in which finely divided lignocellulosic material is defibrated after pretreatment and the resultant pulp is bleached in the form of a suspension with bleaching agent that increases the anionic charge of the pulp fibres, whereafter the pulp suspension is cleaned and then possibly further treated, for instance bleached, characterised in that the defibration is effected with the aid of

a) a refiner that has counter-rotating refining discs while using an extra high temperature (HTDD), or

b) a refiner that has a single rotating refining disc(s) having a single refining zone or two parallel refining zones, while using an extra high temperature and while rotating the disc(s) at an extra high speed (RTS), and in that the cleaning treatment comprises first screening the pulp suspension and then hydrocyclone cleaning said suspension, wherewith the reject obtained with each cleaning process is treated individually and the treated reject is returned to the advancing pulp suspension.

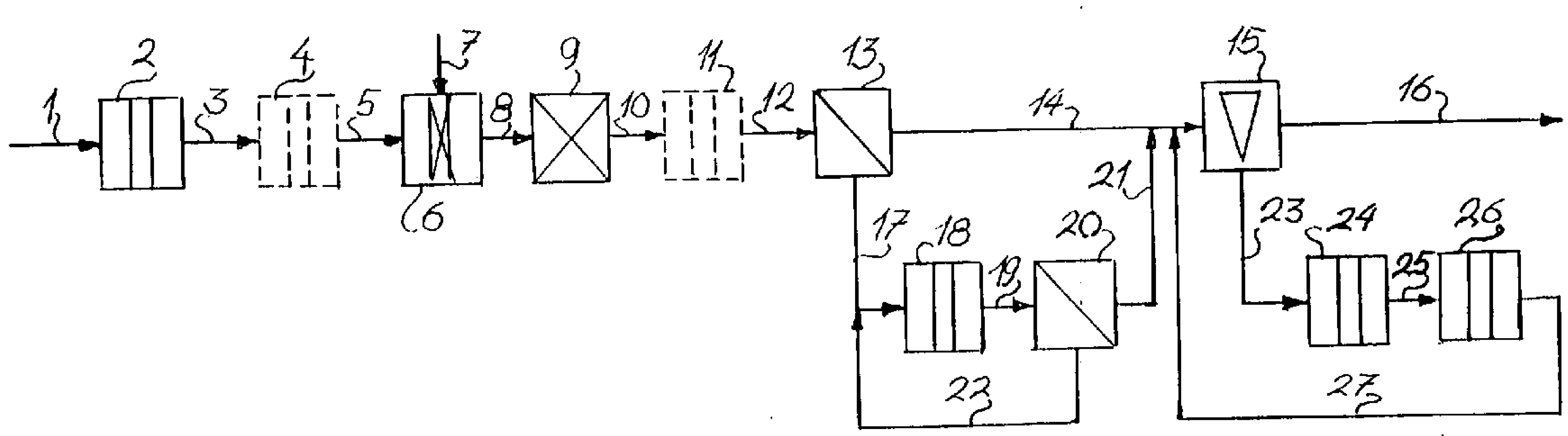
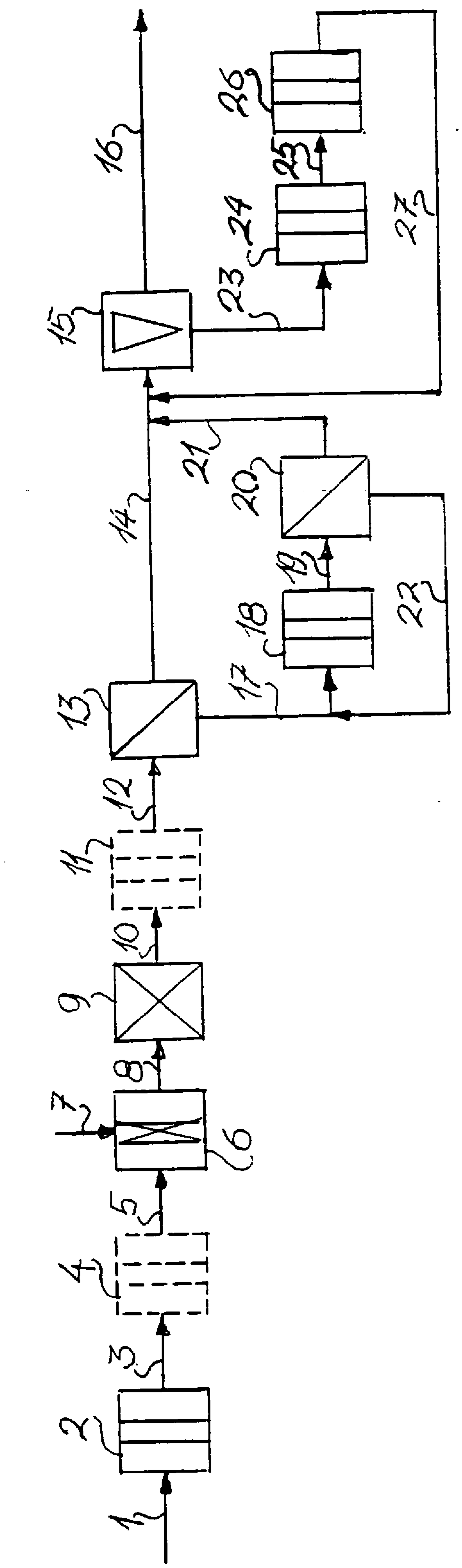


Fig. 1



METHOD OF PRODUCING BLEACHED THERMOMECHANICAL PULP (TMP) OR BLEACHED CHEMITHERMOMECHANICAL PULP (CTMP)

TECHNICAL FIELD

[0001] The present invention relates to a method of producing bleached thermomechanical pulp or bleached chemithermomechanical pulp.

[0002] By thermomechanical pulp is meant a pulp where the fibres of the incoming pretreated lignocellulosic material have been mutually separated with the aid of one or more refiners at elevated temperature and elevated pressure. The lignocellulosic material is normally pretreated by presteaming, chip washing, steaming and a possible impregnation solely with water or with an aqueous solution of a complexing agent. The production of chemithermomechanical pulp is similar to the production of thermomechanical pulp, to a large extent. The main difference resides in including in the pretreatment process a step in which a sodium sulphite solution is added to the lignocellulosic material over a given time period and at a given temperature. The pulp yield is therewith normally one or two percent lower than the yield of thermomechanical pulp.

[0003] Any lignocellulosic material whatsoever can be used as a starting material in the production of these types of pulps. Examples of such materials are bamboo, straw, bagasse, kenaf and wood. Wood is the preferred starting material, and both softwood and hardwood can be used to a high degree, either individually or in mixture. Initially in the pulp manufacturing process, wood in the form of barked logs is normally chopped into an innumerable number of chips.

[0004] The ready treated and final pulp, which is either delivered to a paper machine or converted into a storable pulp, is bleached with an oxidative bleaching agent relatively early in the production process, in one or more stages.

[0005] The finished pulp may be used for the production of any type of wood-containing paper whatsoever. Examples of such papers are magazine paper of the LWC-type (Light Weight Coated) i.e. coated paper in a low grammage and MF (Machine Finished), i.e. paper glazed in the machine. The pulp is particularly suited for the production of the SC-type (Super Calendered) magazine paper. This magazine paper may, in turn, be divided into the classes SC-A, SC-A+ and SC-A++, all of which qualities can be produced beneficially with pulp produced in accordance with the invention. Pulp produced in accordance with the invention may be the sole starting pulp in the production of the aforesaid types of paper, or, with respect to quantity, may be the dominating pulp when using two or more starting pulps.

BACKGROUND ART

[0006] The separation of fibres in the lignocellulosic material usually in the form of wood chips is of central significance in both the production of TMP and of CTMP. Defibration, or fibre separation, is effected with the aid of one refiner or several refiners in series. Different types of refiners are known to the art. The majority of refiners include two refining discs between which the goods under treatment are caused to pass. Normally, one disc is stationary while the other rotates at a high speed. This type of refiner is normally referred to as a single disc refiner.

[0007] A second type of refiner is one in which both discs rotate in mutually opposite directions. This type of refiner may be referred to as a double disc refiner.

[0008] A third type of refiner has four discs, in which a centrally located rotor has refining discs fitted on both sides thereof. Such a refiner has two parallel refining zones. This type of refiner may also be referred to as a single disc refiner, as both refining zones are considered as individual zones.

[0009] A fourth type of refiner is one in which both the static part, on which refining segments have been mounted, and the rotor part, on which refining segments have been mounted have a conical configuration resulting in a conical refining zone. This refiner can be compared with a single disc refiner having one refining zone, and is usually referred to as a cone refiner.

[0010] The choice of refiner and the number of refiners used in series in respect of defibrating the lignocellulosic material depends greatly on the type of TMP and CTMP to be produced, in other words on the quality specifications that must be fulfilled. In turn, this is dependent on, for example, the type of wood-containing paper that shall be produced from the pulp.

[0011] There exists a pulp production method in which two single disc refiners each having one refining zone are used in series. The two refiners normally have a temperature of about 140° C. with the pressure normally reaching about 4 bar. The refiner disc of respective refiner normally rotates at a speed in the range of 1500-1800 revolutions per minute (rpm). This pulp production method can be designated a two stage process, with emphasis on the defibration part of the process.

[0012] The lignocellulosic material can be treated in the following way prior to defibration. When wood, normally in the form of logs, is used as a starting material, an initial stage is to remove the bark from the logs, whereafter the logs are chopped to chips. The chips are handled in a certain fashion, and the chips accepted for pulp production are normally presteamed, washed, steamed and possibly impregnated with water either in the presence of or in the absence of a complexing agent. The chips are preheated at over-pressure, immediately prior to being fed to the first refiner.

[0013] The pulp formed in the first refiner, in other words the first stage pulp, is blown to the second refiner via a steam cyclone. After passing through this refiner, the material, in other words the second stage pulp, is blown to a pulper, via a steam cyclone or vapour cyclone. The incoming pulp has a consistency of about 40%, this consistency being reduced, e.g., to about 2-4% in the pulper, normally with the aid of white water. The pulp suspension is then passed to a latency tank, in which the pulp fibres are allowed to straighten out. The pulp suspension may be further diluted, normally with white water, during its journey to the latency tank or, alternatively, in the tank itself. In this regard, the pulp consistency may be further reduced, for instance by 0.5-1 percent. It is fully possible to exclude the use of said pulper and to allow the second stage pulp to be fed directly to the latency tank, via a vapour cyclone and a conduit, or, alternatively, a screw feeder. In this case, the consistency of the pulp is lowered immediately prior to or in said tank while stirring the pulp suspension. The pulp is pumped from the latency tank to a screening tank, which may be common to a number of identical lines for the manufacture of thermo-mechanical pulp, for example.

[0014] The pulp is pumped from the screening tank to a screen room in which the pulp is divided into accept pulp and reject pulp. The accept pulp normally consists of 50-70% of the incoming flow of pulp fibre. This pulp flow has a low shive content and a slightly elevated proportion of well-worked pulp fibres. The reject pulp normally consists of 30-50% of the incoming flow of pulp fibres and is passed for washing and pressing via a reject pulp tank, wherein the pulp consistency thus attained is normally greater than 30%. This reject pulp is usually refined in two mutually sequential refiners having single rotating refining discs and a single refining zone. The pressure and temperature prevailing in the refiners are the same as that in the introductory defibration of the lignocellulosic material. The speed at which the refining disc rotates is also the same. The refine reject pulp is blown to a pulper, via a vapour cyclone, or, alternatively, directly to a latency tank. This handling of the reject pulp may be in total accord with what has been said earlier with regard to the main pulp suspension flow. The reject pulp is then screened again in reject screens and the reject obtained in this position, i.e. reject of the reject pulp, is passed back to the reject pulp tank. Accept pulp, i.e. reject pulp accepted in this position, is passed to a bleaching department together with the accept pulp in the main pulp suspension flow, via pulp tanks and a pulp de-watering station. In this position of the process, the pulp will normally have a freeness value of 30-40 ml. In this latter respect, by freeness as used throughout this document is meant CSF, i.e. Canadian Standard Freeness. The value is a measurement of the de-watering capacity of the pulp. The pulp can be bleached in the bleaching department either with an oxidative bleaching agent or a reductive bleaching agent. Per-compounds dominate among oxidative bleaching agents, among them sodium peroxide and hydrogen peroxide, while dithionite dominates among reductive bleaching agents, normally sodium dithionite. The finished, bleached pulp is then usually passed to a paper machine.

[0015] In a second pulp manufacturing method, three refiners are used in series. The two first refiners are mutually identical and each have two refining zones and single rotating refining discs mounted on respective sides of a central rotor. The third refiner has one refining zone with a single rotating refiner disc. Pressure, temperature and speed of respective refining discs are mutually the same in all refiners, wherewith respective digital values reach about 4 bar, about 140° C. and 1500-1800 rpm. This pulp production method can be designated as a three-stage process, and then with emphasis on the defibration part of the process.

[0016] Prior to defibration, the lignocellulosic material is normally treated in the same way as that described with respect to the two stage process. The pulp formed in the first refiner, i.e. the first stage pulp, is blown to the second refiner via a vapour cyclone. Subsequent to its passage through this refiner, the material, i.e. the second stage pulp, is blown to the third refiner via a vapour cyclone. Subsequent to passing through this refiner, the material, i.e. the third stage pulp, is treated in the same way as that described above, i.e. in the two stage process, up to the screening room.

[0017] The screening of the pulp and the handling of the reject pulp obtained differs in this three stage process from the procedure applicable to the afordescribed two stage process. Firstly, the screening process is set, so that about 70% of the incoming pulp fibres will be accepted and form accept pulp. This pulp has a low shive content and a somewhat elevated proportion of well-worked pulp fibres. Secondly, the reject pulp, which constitutes about 30% of the pulp fibres arriving at the screening room, is handled in the following way. As is normal, the flow of reject pulp is passed, via a pulp tank, to a de-watering and pressing station, where the pulp consistency is normally increased to above 30%. Instead of being passed to a separate refiner, the reject pulp is then passed directly to the second refiner in the defibration line, whereby the reject pulp is re-combined with the main pulp suspension flow. As will be apparent, this pulp production method is effected in the absence of separate reject refinement and separate reject screening. The accept pulp leaving the screening room is treated in the same way as that described above with reference to the two stage process.

[0018] In a third pulp production method, which can be designated an alternative three stage process, the procedure is as follows. As indicated above, this method also uses three refiners in series in the defibration line. The second refiner and the third refiner are both identical with the refiners used in accordance with the described three stage process. This implies that the conditions prevailing in respective refiners, i.e. the operating parameters, are also identical. The difference resides in the first refiner and the operating parameters in the first refining stage. This first refiner is of the type that has two refining zones and single rotating refining discs mounted on respective sides of a centre rotor. The operating parameters are changed insofar that the pressure is extra high, about 6 bar, whereby the temperature is extra high and about 160° C., and the speed of the discs is also extra high and elevated to somewhere within the range of 2000-3000 rpm, for example 2300 or 2600 rpm.

[0019] The treatment of the lignocellulosic material prior to the defibration process coincides to a great extent with the earlier described pretreatment process. There are, however, two essential differences. Subsequent to steaming the wood chips, which is the most usual lignocellulosic material, the wood chips are caused to pass through an apparatus which disintegrates the chips to some extent, i.e. ensures that the chips contain longitudinally extending cracks which will result in the chips being divided at least partially into sticks that have a width of several millimetres. With regard to preheating of the lignocellulosic material prior to said material being fed into the first refiner, the preheating process is effected at an extra elevated pressure, namely a pressure of about 6 bar, which coincides with the pressure in the first refiner, and thereby also at an extra elevated temperature of about 160° C. The residence time, or stay time, in the preheating stage is very short, more specifically a period of about 10 seconds. The pulp from the third refiner, i.e. the third stage pulp, is handled in a manner identical with that earlier described, up to the screening room.

[0020] In this third pulp production method, the pulp suspension is not only cleansed by screening, but also by a downstream hydrocyclone treatment. The screening process is set, so that about 70% of incoming pulp fibres will be accepted to form accept pulp. This accept pulp is passed to a hydrocyclone treatment. About 15-20% of the incoming pulp fibres are taken out as reject in this treatment. This flow of reject pulp is mixed with the flow of the reject pulp from the screening room, which constitutes about 30% of the pulp fibres entering the screening room. The treatment of this combined flow of reject pulp is, to a large degree, similar to the way in which screening reject pulp is handled in the aforedescribed two stage process. However, there is a difference with respect to the final handling of the refined reject pulp. In this case, this pulp is cleaned by causing the pulp to pass through both a reject screening room and reject cyclones. Subsequent to these stages, the accept pulp is fed into the flow of main pulp suspension somewhere downstream of the hydrocyclone stage. The reject pulp obtained in this position is passed back to the reject pulp tank. The final and total accept pulp is treated in a manner similar to that described earlier, both with regard to the two stage process and the three stage process with the exception of one item in the pulp bleaching process, which according to this pulp production method is normally effected with peroxide and then primarily with hydrogen peroxide, at a high pulp consistency.

[0021] The bleaching of the pulp is undertaken late in the production chain, in all of the aforedescribed pulp production methods. However, it is earlier known from the literature and/or from actual practice to bleach the pulp in an early stage of the pulp production process, for instance prior to cleaning the pulp, i.e. upstream of the usually pulp screening process.

[0022] All of the pulps produced in accordance with the aforedescribed methods can be used as a fibre base in the manufacture of different types of magazine paper, for example. However, with regard to the fibre part of magazine paper, it is not possible to base said paper completely on these pulps, but that a given admixture of chemical pulp, and then preferably long-fibre kraft pulp, must be used. The admixture of such pulp in the pulp furnish normally lies in the range of 10-20%, meaning that 80-90% consists of the described mechanical pulps. Chemical pulp fibres, and then particularly the long fibres of kraft pulp produced from softwood, are to be considered as reinforcement fibres in the magazine paper. It is endeavoured to reduce the proportion of chemical pulp in the furnish as far as possible, since this type of pulp is much more expensive than TMP and CTMP.

[0023] With regard to the pulp furnish, in addition to using bleached TMP or bleached CTMP in a high degree in the production of magazine paper, several paper makers use at the present time a mixture of bleached groundwood pulp (instead of the aforesaid mechanical pulps) and bleached chemical pulp, and then primarily long-fibre kraft pulp. In such cases, there is used a higher proportion of kraft pulp than that previously mentioned, for instance 33%, while the remainder, e.g. 67%, consists of groundwood pulp. The higher cost involved by the use of such a high percentage of bleached long-fibre kraft pulp is compensated for by the use of bleached groundwood pulp, which, from an energy aspect, is cheaper than either bleached TMP or bleached CTMP. Furthermore, groundwood pulp has a great advantage in comparison with known TMP and CTMP pulps with regard to optical properties, and then particularly its high light scattering capacity.

DISCLOSURE OF THE INVENTION

[0024] Technical Problems

[0025] There is a need of a cheaper way for manufacturing bleached TMP and bleached CTMP, while ensuring that the strength properties of pulps of this type are at least equal to those hitherto produced and that they have optical properties, primarily a light scattering capacity, that exceeds the light scattering capacity of bleached TMP and bleached CTMP produced in accordance with known technology, and approaching the light scattering ability of bleached groundwood pulp.

[0026] The Solution

[0027] The present invention satisfies this requirement and provides a solution to existing problems, and relates to a method of producing bleached thermomechanical pulp (TMP) or bleached chemithermomechanical pulp (CTMP), including defibrating finely-divided lignocellulosic material, such as wood chips, subsequent to pretreatment, bleaching a suspension of the resultant pulp with bleaching agent that enhances the anionic charge of the pulp fibres, whereafter the pulp suspension is subjected to a cleaning process and thereafter possibly further treated, for instance bleached, before being delivered to a paper machine or being converted to a storable pulp, wherein the method is characterised by defibrating said lignocellulosic material with the aid of a) a refiner that includes counter-rotating refining discs while using extra high temperature (HTDD) either with or without an immediate subsequent refining stage, or b) a refiner that includes a single rotating refining disc(s) in one refining zone or in two parallel refining zones while using extra high temperature and extra high rotational speed of the refining disc(s) (RTS) with or without immediate subsequent refining stage; and wherein the cleaning treatment comprises first screening the pulp suspension and then hydrocyclone cleaning said pulp suspension, and wherein reject obtained in each cleaning process is treated per se and the treated reject returned to the forwardly flowing pulp suspension.

[0028] The aforesaid acronyms HTDD and RTS are respective abbreviations for "High Temperature Double Disc" and "low Retention, high Temperautre, high Speed".

[0029] As has been made apparent, the defibration of the lignocellulosic material shall take place in a certain way. This implies that it may suffice with one initial defibration or fibre separation stage in the form of an HTDD stage or an RTS stage. Whether or not one initial defibration stage will suffice depends on a number of different factors. Examples of such factors include the relationship between desired pulp production and available refiner sizes, the choice of an HTDD stage or an RTS stage, the freeness of the pulp after the first refining stage, whether or not a refining stage is present immediately after the bleaching of the pulp. This will be explained in detail further on in the text. A single disc refiner having a single refining zone can be used beneficially when choosing an initial and supplementary second refiner stage.

[0030] With regard to the pretreatment of the lignocellulosic material, any known pretreatment method may be used, including the pretreatment methods that have already been described in this document.

[0031] In the case of the inventive method, the pulp, or more to the point the pulp suspension, is bleached in an early stage of the pulp production chain, more specifically after the introductory defibration process and subsequent to the pulp suspension being passed to a possible pulper and a latency tank and possibly de-watering and pressing of the pulp. The pulp shall be bleached with a bleaching agent that increases the anionic charge of the pulp fibres, in other words with an oxidative bleaching agent. A number of oxidative bleaching agents are available, such as chlorine dioxide, oxygen, ozone and different per-compounds. This latter type of bleaching agent is preferred. Examples of per-compounds are peroxides such as sodium peroxide and hydrogen peroxide, per-acids, per-acidic acid and per-oxo-sulphuric acid (Caros acid), perborates and polyoxomethalates. Hydrogen peroxide is the bleaching agent most commonly used among the per-compounds. For example, when it is elected to bleach with hydrogen peroxide the bleaching process can be carried out at any pulp consistency whatsoever, i.e. at low consistency, medium consistency, or high consistency. The pulp can be bleached in one or more stages. When using a multistage bleaching process, the pulp consistency may be the same or different in the various stages, for example medium consistency stage followed by a high consistency stage.

[0032] The bleached pulp may be refined one more time, optionally after washing the pulp and/or increasing pulp consistency. This refinement can either take place with a high pulp consistency or with a low pulp consistency. Low consistency refinement is more energy effective than high consistency refinement. An appropriate refiner is a single disc refiner that has only one refining zone. The earlier described third type of refiner having two parallel refining zones is particularly suitable for use in low consistency refinement of the pulp in this position. This refining stage enables the freeness value of the pulp to be finely adjusted, resulting, inter alia, in an optimal cleaning treatment of the bleached pulp obtained.

[0033] The cleaning treatment of the pulp is characterised by first screening the main pulp suspension flow and then hydrocyclone cleaning the pulp, and is especially characterised in that when screening the pulp a comparatively low amount of pulp fibres are taken from the main pulp suspension stream as reject, reaching to at most 20%, and in that when hydrocyclone cleaning of the pulp a comparatively large amount of pulp fibres are taken from the main pulp suspension flow as reject, reaching to at least 30%. A further characteristic feature of the inventive method is that the two resultant reject pulps are treated individually and similarly each converted to accept pulp prior to said two accept converted pulp flows being delivered, either individually or in mixture, to the main pulp flow in a position downstream of the screening and upstream of the hydrocyclone treatment.

[0034] With regard to the reject obtained when screening the main pulp suspension flow, this material is caused to pass through one or two refiners in series. With respect to the type of refiner used, the single disc refiner having a single refining zone is preferred. The refinement of the screening reject pulp can be effected at either a high pulp consistency or at a low pulp consistency. When two refining stages are used, it is preferred that the first refining stage is effected at a high pulp consistency and the other at a low pulp consistency. The thus refined pulp suspension is screened in a screening room included in the screened reject handling system, resulting in an accept pulp flow and a reject pulp flow. The accept pulp flow is delivered to the main pulp suspension flow, as earlier described. It is preferred that the reject pulp flow is returned to the screened reject handling system and again refined in one or two stages.

[0035] With regard to the reject obtained when hydrocyclone cleaning the main pulp suspension flow, this material is preferably caused to pass through two refiners in series. Single disc refiners having a single refining zone are suitable types of refiner in this regard. It is preferred that the first refiner operates at high pulp consistencies, and that the second refiner operates at low pulp consistencies. The second refiner may conveniently consist of a conical refiner. All of the refined hydrocyclone cleaner reject is delivered in the form of an accept pulp flow to the main pulp suspension flow in the aforedescribed manner. A very large number of hydrocyclone cleaners are used for hydrocyclone cleaning of the pulp suspension, these cleaners normally being arranged in stacks and are fully coupled in cascade.

[0036] The main pulp suspension flow, i.e. the cleaned pulp, can then be handled in several ways. Because the consistency of the pulp suspension is very low, for instance beneath 1%, when screening and hydrocyclone cleaning said suspension, the main pulp suspension flow is normally caused to pass through a de-watering filter, with which the pulp consistency is raised to about 10%. The pulp suspension is normally passed from the de-watering filter or filters to a storage silo. The pulp suspension is normally diluted with white water, either on its way to the storage silo or in the silo itself, such as to obtain a pulp consistency of 4-5% for example. Instead of transporting the finished pulp in the form of a suspension directly to a storage silo or tower, there can be used a finished pulp tank situated somewhere between the de-watering filter or filters and the storage silo. In such cases, the pulp suspension can be diluted with white water in two stages, i.e. both upstream of or in the finished pulp tank, so as to achieve a temporary pulp consistency of about 5-6% and to obtain a pulp consistency in the storage silo of 4-5% for example, downstream of the finished pulp tank or in said storage silo.

[0037] If the described pulp production takes place in an integrated pulp and paper mill, the pulp suspension is taken from the storage silo to the paper machine as required.

[0038] If the described pulp production takes place in a pulp marketing mill, the pulp suspension is taken from the storage silo to a wet machine in which pulp sheets of high dry content are formed and packed into pulp bales. An alternative conversion method is to flash-dry the pulp and press the flash-dried pulp into cakes of high dry solids content.

[0039] Although it is not necessary to extend the inventive method with one or more further treatment stages with the intention of improving and/or further refining the pulp produced, the pulp manufacturer is quite free to do so. For example, the pulp can be further bleached in at least one stage, after the cleaning treatment. This bleaching can be effected with any known bleaching agent normally used when bleaching mechanical pulp, including both oxidative and reductive bleaching agents. Other known pulp improving and/or refining stages may also be used.

[0040] Advantages

[0041] The cost of producing bleached TMP in accordance with the present invention is significantly lower than the cost of producing bleached TMP in accordance with known production methods. This is because the fixed cost and the variable cost involved with respect to the inventive method both lie beneath the corresponding cost involved by known methods of producing such pulp. The lowering of the fixed cost is coupled directly to the fact that the machine park or apparatus set-up required in respect of the inventive method is cheaper than the machine parks or apparatus set-ups hitherto used. The lowering in variable costs is primarily coupled to the fact that the consumption of electrical energy with respect to the production of a given quantity of pulp in accordance with the invention is less than the consumption of electrical energy involved in the production of the same quantity of pulp in accordance with known technology. The amount of electrical energy consumed in respect of the known methods of producing bleached TMP is not uniform, but exceeds the amount of electrical energy consumed in respect of the inventive method by varying amounts.

[0042] With regard to the strength properties of bleached TMP produced in accordance with the invention, these properties are at least equal to the strength properties of bleached TMP produced in accordance with known technology.

[0043] With regard to the optical properties of the pulp, which are important in the present context, and then primarily the light scattering ability of the pulp, the pulp produced in accordance with the invention has a clear advantage over those pulps produced in accordance with known technology.

[0044] Another advantage afforded by the bleached TMP produced in accordance with the invention is that the shive content of the pulp concerned is surprisingly much lower than the shive content of corresponding pulps produced in accordance with known technology. The aforesaid advantages also apply to the production of bleached CTMP produced in accordance with the invention, in comparison with the production of bleached CTMP in accordance with known technologies.

[0045] There are a number of hypotheses as to why it is possible to produce in accordance with the invention a pulp at much lower production costs and far improved properties in certain aspects than those that can be achieved with known technology. It is believed that the improved light scattering ability of the pulp can be attributed primarily to the defibration method in the form of an introductory HTDD stage or RTS stage. It is also believed that the low total consumption of electrical energy, i.e. a summation of the electrical energy consumed in all refiners included in the machine park, is tied, at least to some extent, to the fact that the pulp is bleached with an oxidative bleaching agent in an early stage of the production or treatment chain. It has namely been found that reject pulp, and particularly reject pulp obtained when hydrocyclone cleaning a pulp suspension, can be refined much more readily than a corresponding unbleached reject pulp, i.e. not bleached with an oxidative bleaching agent, or a corresponding reject pulp emanating from a pulp that has been bleached with a reductive bleaching agent. Among other things, this fact forms a basis of the choice to carry away as reject far more pulp fibres in the hydrocyclone cleaning process than in the screening process, in contradistinction to known technology. It is thought that the reason why the reject pulp concerned, i.e. the reject obtained when applying the inventive method, can be refined so easily is due to the increase in the charge in the fibres (from about 100 microequivalents to over 200 microequivalents) and to a decreased softening temperature of the lignin in the fibres (from about 75° C. to about 60° C.). Due to the morphological constitution of the fibre material, it is the thick-walled summer fibres that are most positively affected with regard to refinability and property development. The charge increase is due primarily to the creation of carboxyl groups in the lignin as a result of bleaching with an oxidative bleaching agent. The majority of the lignin is found in the S2-layer of the fibre walls, this layer being thickest precisely with summer fibres. It is known that the primary cause of improved energy efficiency when refining pulp fibres is an enhanced degree of swelling in the fibre wall. It can possibly be expected that the relative influence of the refinement on just summer fibres will be greater than the influence on spring fibres, since the number of charges in the summer fibres should have increased more than in the spring fibres in absolute numbers.

[0046] However, the charge content of the lignin in respective fibre walls is probably about the same. It is also believed that the aforedescribed reject refining efficiency also explains the extremely low shive content of the pulp.

DESCRIPTION OF THE DRAWING

[0047] **FIG. 1** is a simplified flowchart describing the production of bleached TMP or bleached CTMP in accordance with the inventive method. A large number of treatment stages have been omitted from the flowchart, which illustrates solely those treatment stages that have particular significance to the application of the invention.

BEST EMBODIMENT

[0048] There will now be described with reference to the flowchart of **FIG. 1 a** number of embodiments of the inventive method where certain conditions are explained relatively thoroughly followed by two examples.

[0049] Shown in **FIG. 1** is a first pulp line **1** and a first refiner **2**. These are followed by a second pulp line **3** and a possible second refiner **4**, which is/are followed by still another pulp line **5**, which extends to a mixer **6**. An oxidative bleaching agent is delivered to the mixer, and therewith also to the pulp suspension inside the mixer, through the line **7**. There then follows a pulp line **8** which opens into a bleaching tower **9**. Extending from the bleaching tower **9** is a pulp line **10** which opens into a possible third refiner **11**. There then follows a pulp line **12** which opens into a screening room **13**. Accept pulp is passed through the line **14** to a hydrocyclone cleaning plant **15**. The accept pulp is normally passed in this position to a de-watering filter (not shown in the figure) through the line **16**.

[0050] Reject pulp obtained in the screening room **13** is passed to a refiner **18**, through the line **17**. There then follows a pulp line **19**, which opens into a screening room **20**. In this position, the accept pulp is passed through the line **21** to the main pulp suspension flow in said line **14**. The reject pulp in this position is passed via the line **22** to the line **17**, which opens into the refiner **18**.

[0051] Reject pulp obtained in the hydrocyclone cleaner is passed via the line **23** to a refiner **24** which is the first refiner in this system. The pulp is then passed through the line **25**, to a second refiner **26** in this system. The finally refined reject pulp from the hydrocyclone cleaning is passed through the line **27** back to the main pulp suspension flow in line **14**.

[0052] According to a first embodiment of the inventive method, which is also the simplest possible method according to the invention, the method is carried out as follows.

[0053] The lignocellulosic material, pretreated in any know way, normally in the form of wood chips, is passed from the preheating vessel (not shown in the figure), in which the material has been kept over a given period of time and under elevated pressure and elevated temperature, to an HTDD-type refiner **2** through the line **1**. The pulp suspension resulting from defibration is delivered to a possible pulper (not shown in the figure) via a vapour cyclone (not shown in the figure) and via the lines **3** and **5**, and from there to a latency tank (not shown in the figure). The pulp is then passed to the mixer **6**, where an oxidative bleaching agent is delivered to the pulp suspension via the line **7**. A preferred oxidative bleaching agent is hydrogen peroxide. An alkali, normally sodium hydroxide, is added in addition to hydrogen peroxide. Certain other additive chemicals, such as water glass and magnesium sulphate for example, may also be added to the pulp suspension. The pulp suspension is then pumped to the bleaching tower **9**. When bleaching is completed, and optionally after washing the pulp, the pulp is passed to the screening room **13**, through lines **10** and **12**, as it is diluted.

[0054] According to one preferred embodiment of the inventive method, at least 80% of the pulp fibres arriving at the screening room pass through said room as accept pulp, wherewith this pulp suspension is transported through the pulp line **14** to the hydrocyclone cleaning plant **15** where at most 70% of the pulp fibres arriving at the screening room are allowed to pass through the hydrocyclone cleaning as accept pulp, which is transported further via the line **16**. The manner in which the screening reject and the hydrocyclone cleaning reject are handled has been described in detail in the aforegoing.

[0055] According to this embodiment of the invention, the lignocellulosic material is treated solely in one refiner in the main line, i.e. in the treatment system **1** to **16**, namely in the HTDD refiner in position **2**. This is possible when a number of conditions are fulfilled. Firstly, the material load on the refiner must not be too high, i.e. the capacity of the refiner will preferably exceed the amount of lignocellulosic material delivered to the refiner per unit of time, or, at most, the supply of lignocellulosic material shall be on a level with the capacity of the refiner. Secondly, the freeness of the pulp subsequent to defibration shall lie on a level which enables cleaning of the pulp suspension to be carried out in the aforedescribed manner.

[0056] A second embodiment of the inventive method can be applied, when the capacity of the HTDD refiner is slightly less than the amount of lignocellulosic material delivered. In this case, in addition to the lignocellulosic material being defibred at least to a certain extent in position **2**, the resultant pulp suspension is refined either in position **4** or in position **11**. A single disc refiner having one refining zone may be used beneficially in position **4**. Refinement is suitably effected at a high consistency. In position **11**, it is preferred to apply low consistency refinement and preferably with the aid of a single disc refiner having two parallel refining zones.

[0057] Although not preferred directly, a third embodiment of the inventive method enables the use of all three described refining stages, i.e. in positions **2**, **4** and **11**. In this case, it is important that these three refinement stages are combined and balanced against each other so that the total consumption of electrical energy will be kept at an acceptable level.

[0058] In a fourth embodiment of the inventive method, the HTDD refiner in position **2** is changed for an RTS refiner. In this case, it is usually necessary to supplement the introductory defibration stage with refinement of the obtained pulp suspension in position **4**. A single disc refiner having a single refinement zone may also be used beneficially in this case. Refinement is preferably effected at high consistency.

[0059] Although not preferred directly, in a fifth embodiment of the inventive method the newly described method is supplemented with refinement of the pulp suspension in position **11**. What has been said above with respect to the third embodiment of the inventive method is also applicable in this case.

[0060] With regard to the early oxidative bleaching of the pulp suspension, this is shown in its simplest form in **FIG. 1** and solely by means of a chemical mixer **6** and a bleaching tower **9**. As will be evident from the aforegoing, the oxidative bleaching of the pulp suspension can be effected at any known pulp consistency. Moreover, the bleaching process can be carried out in two or more stages, in addition to a single stage. Apparatus necessary for carrying out the various bleaching processes have, for obvious reasons, not been included in the highly schematic and stylised **FIG. 1**.

[0061] The screening tank normally provided upstream of the screening room **13** has not been shown in **FIG. 1**, and neither has the apparatus used to increase and decrease the pulp fibre consistency in the pulp suspension.

EXAMPLE 1

[0062] An inventive pulp was produced on a full scale, i.e. in a TMP mill, up to the bleaching stage. The pulp was then transported by a tanker to a laboratory, where the inventive method was continued on a pilot-plant scale.

[0063] The starting material used in the pulp production was fresh Scandinavian spruce. After having been barked, the spruce logs were chopped into chips. The chips were then typically sorted and the accepted chips pretreated as follows. The chips were preheated in a thermoscrew with the aid of steam in an amount corresponding to 102 kg per tonne of chips. The chips were then washed with the aid of rising screws of the Sunds Defibrator type. This was followed by feeding the chips into a steaming vessel having a temperature of 93° C. The throughflow time was 3 minutes. The steamed chips were then fed into a compression screw, after which the material was fed into a water-containing impregnation vessel. The temperature was kept at 71° C. for a period of time so that the chips became fully impregnated with water.

[0064] The chips were then fed into a preheating vessel having a temperature of 155° C. and a pressure of 5.5 bar. The throughflow time was a few seconds. The chips were then fed into a double disc refiner, i.e. a refiner having two counter-rotating refining discs with a diameter of 70 inches and being of the type Sunds Defibrator RGP68DD. The pressure and temperature in the refiner were the same as those in the preheating vessel. The refining discs rotated at a speed of 1500 rpm. The defibrated wood material, i.e. the pulp obtained, was blown through a conduit line to a vapour cyclone, in which the major part of the occurring vapour was led away at the same time as the pulp suspension, with a pulp consistency of about 40%, was passed through a conduit line to a latency tank in which the pulp consistency was reduced to 4% with the aid of white water. The pulp had a freeness value of 120 ml. The load on, or the production in, the refiner was 12.5 tonnes of pulp per hour, and the energy input reached to 1520 Kwh per tonne of pulp.

[0065] The 4 percent-pulp suspension was pumped from the latency tank into a tanker, which transported the pulp suspension to a laboratory in which the suspension was initially dewatered on a belt press to a pulp consistency of 30%.

[0066] The pulp was then bleached with hydrogen peroxide at this consistency. The temperature was 80° C. and the time 120 minutes. In addition to adding hydrogen peroxide in an amount corresponding to 30 kg per tonne pulp, 10 kg sodium silicate were added per tonne of pulp and 20 kg sodium hydroxide per tonne pulp. These chemicals were mixed into the pulp suspension with the aid of a single disc refiner of the type Sunds Defibrator RGP42. The pulp fibres were refined marginally concurrently with mixing said chemicals into the pulp suspension.

[0067] Prior to subjecting the pulp suspension to the next treatment stage, i.e. screening, the pulp suspension was diluted, or thinned, with water such as to lower the pulp consistency to 1.2%. Screening was effected in a slotted screen with a slot width of 0.15 mm. 20% of the incoming pulp fibres were rejected, meaning that the accept pulp was 80% of the incoming pulp fibres.

[0068] The accept pulp suspension was de-watered on a disc filter and the water taken from the suspension was passed back for diluting the pulp suspension entering the screening stage, so as to minimise the loss of fine material. The reject pulp suspension was de-watered on a belt press to a pulp consistency of 30%. This pulp suspension was caused to pas through a single disc refiner of the type Sunds Defibrator RGP42. The pressure and the temperature in the refiner were respectively 3 bar and 130° C., and the refiner disc rotated at a speed of 1500 rpm. This refined reject pulp had a freeness value of 120 ml. According to the invention, it is suitable to re-screen this pulp suspension and to subject the reject obtained in the screening process to renewed refinement, in accordance with the aforegoing. In the case of this trial run, this handling step happened to be excluded.

[0069] The accept pulp suspension and the refined reject pulp suspension were mixed and diluted with water to a pulp consistency of 1.0%. This pulp suspension was passed to a stack of hydrocyclone cleaners of the type NOSS AM 80F. At the hydrocyclone cleaning of the pulp suspension, which was carried out, 35% of the incoming pulp fibres were taken out as reject pulp, whereas 65% of the incoming pulp fibres were taken out as accept pulp. This pulp has a freeness value of 30 ml. The accept pulp suspension was de-watered on a disc filter and the water extracted was used for diluting the pulp suspension entering the hydrocyclone cleaners. The reject pulp suspension was de-watered on a disc filter and a belt press, such as to obtain a pulp consistency of 30%. This pulp suspension was caused to pass through a single disc refiner of the type Sunds Defibrator RGP42. The refiner pressure and temperature were respectively 1.5 bar and 111° C. and the disc rotated at a speed of 1500 rpm. The refined pulp had a freeness value of 80 ml. This pulp suspension was diluted with water and subjected to renewed hydrocyclone cleaning. The resultant accept pulp had a freeness value of 30 ml. The very low quantity of reject pulp obtained was passed to an outlet or drain in the case of this trial. The two accept pulp fractions were mixed to produce the final finished pulp.

[0070] Table 1 below shows certain quality parameters of the pulp and the specific energy consumption in comparison with corresponding objects of pulps produced in accordance with known technology.

TABLE 1

Pulp properties and energy consumption		Pulp produced acc. to the invention	Pulp produced acc. to conv. 2-step method	Pulp produced acc. to conv. 3-step method	Pulp produced acc. to 3-step method (RTS)
Freeness (CSF)	ml	30	30	30	30
Tensile index (SCAN M8:76)	Nm/g	53	53	51	52
Tear index (SCAN M8:76)	nNm/g	6.5	6.5	6.5	6.5
Light scattering (SCAN M7:76)	m^2/kg	58	53	54	55
Brightness (ISO 2470:1999)	%	72	72	72	72
PQM shive quantity*	No./g	10	80	80	60
Meanfibre length (PQM 1000)	mm	1.4	1.5	1.5	1.4
Specific energy	Kwh/tonne 90% pulp	2500	3400	3200	2800

*Measurement obtained with an apparatus designated "Pulp Quality Monitor 1000" from "Metso Automation Oy".

[0071] The methods for producing the three comparison pulps have been described under the heading "Background art" in this document. The data given in this respect has been taken from literature relating to these methods.

[0072] As will be evident from the table, the pulp produced in accordance with the invention has a mechanical strength (see the values for tensile index and tear index and mean fibre length) which is on a par with the pulps produced in accordance with known technologhy. This also applies to the brightness of the pulp.

[0073] The light scattering property of the pulp produced in accordance with the invention is clearly better than that of the comparison pulps. The amount of shives present in the inventive pulp is far less than the amount of shives in the comparison pulps. With regard to the specific energy consumption in the inventive pulp production process, it will be evident that the inventive method is clearly best in this respect, followed by the RTS three stage method and then by the conventional three stage method, while the conventional two stage method requires the highest energy input.

[0074] These results confirm the earlier statement that the inventive method leads to a cheaper way of producing bleached TMP, while the pulp properties are comparable in several instances with the pulp properties of known pulps of this kind, and while, in some instances (shive quantity and light scattering) the properties of the inventive pulp are clearly superior to those of known pulps.

[0075] Samples were taken of the bleached thermomechanical pulp produced in accordance with the invention, de-watered and frozen for future production of paper from this pulp.

EXAMPLE 2

[0076] The following trials were carried out in the laboratory, with the intention of simulating full scale manufacture of magazine paper, i.e. manufacture on a paper machine, from two mutually different stocks, one conventional stock and one stock containing bleached TMP produced in accordance with the inventive method, and subsequent supercalendering of the paper.

[0077] There were used three different pulps in the trials, namely a bleached stone groundwood pulp produced from fresh spruce wood, a bleached and two-stage beated pinewood kraft pulp (in a Voith SDM 1-type refiner) and the pulp mentioned in the above example produced in accordance with the invention and stored frozen over a period of time.

[0078] So that all pulps would be treated on an equal basis, the groundwood pulp and the samples of pinewood kraft pulp were both de-watered and then frozen and stored in this way for a week.

[0079] The frozen pulps were removed from the freezer concurrently and allowed to thaw out at room temperature. The pulps were then agitated in water by means of a propeller agitator at a temperature of 85° C., whereafter the pulps were diluted with water to a pulp consistency of 1.5%.

[0080] After the warm pulping at 85° C., the pulps had the following respective freeness values; the groundwood pulp had a freeness value of 31 ml, the pinewood kraft pulp had a freeness value of 189 ml and the pulp produced in accordance with the invention had a freeness value of 28 ml.

[0081] Two different pulp stocks were prepared, one conventional stock consisting in a bone dry state of 50% groundwood pulp, 20% pinewood kraft pulp and 30% kaolin clay, and one novel stock consisting in a bone dry state of 59% of the pulp produced in accordance with the invention, 11% pinewood kraft pulp and 30% kaolin clay.

[0082] The kaolin clay was added as a finished slurry having a dry content of about 28% in both instances, and a retention agent in the form of polyacrylamide whilst added in an amount corresponding to 550 g retention agent per tonne of stock, also in both instances.

[0083] A number of paper sheets were produced from these two stocks on a dynamic sheet former of the Formette-type marketed by the Swedish company Fibertech AB. Here follows some data from the sheet-forming process: The pulp consistency of the stock=0.3%, the nozzle used=No.2510 with a 25° pulp suspension jet angle and a 1.0 mm opening diameter, a drum speed of 1250 revolutions per minute, and a pump pressure for the pulp suspension jet of 3.2 bar.

[0084] The desired grammage of the paper sheets produced was 56 g/m^2, and it was found that all paper sheets produced lay in the grammage range of 56 to 58 g/m^2. The paper sheets obtained were flat pressed at a pressure of 6.3 bar. The paper sheets were then dried in a clamped state in a cylinder drier, wherewith the following parameters were applicable: clamping pressure=1.5 bar, temperature=100° C., rotational speed=1.5 metres per minute, time=5 minutes.

[0085] These paper sheets were calendered in a laboratory calender. The calender included, among other things, a steel roll and a roll provided with a plastic polymer barrel or outer casing having a hardness of 89/91 measured in shore D. The steel roll had a temperature of 70° C. The three different applied pressures were 20 kN/m, 52 kN/m and 131 kN/m. The sheets were advanced at a speed of 12 metres per minute and each sheet was passed through the described press nip three times. It was always the respective upper side of the paper sheets, which were brought into contact with the steel roll.

[0086] These paper sheets were tested with respect to different paper properties. The results obtained will be apparent from Table 2 below.

TABLE 2

Paper property	Unit	Paper produced from conv. stock	Paper produced from stock incl. pulp produced acc. to inv.
Ash content (SCAN P5:63)	%	26.4	28.2
Density (SCAN P7:P96)	kg/m^3	1000	1000
Roughness PPS-1.0 MPa (SCAN P76:95)	μm	1.8	1.7
Oil absorption Cobb Unger (SCAN P37:77)	g/m^2	7.1	5.8
Porosity, Bentsen (SCAN P66:37)	ml/min	44	29
Tensile strength (SCAN P67:93)	N/m	3.0	3.0

TABLE 2-continued

Paper property	Unit	Paper produced from conv. stock	Paper produced from stock incl. pulp produced acc. to inv.
Tear strength (SCAN P11:96)	mNm^2/kg	305	280
Light scattering (SCAN P8:93)	m^2/kg	68.8	65.3

[0087] As will be evident from what has been said by way of introduction, the intention was that the paper would include 30% clay. This was not achieved, however, since the ash content, which is a measurement of the amount of clay present, in one paper was 26.4% and in the other paper 28.2%. This difference in clay content of the two papers has no appreciable effect on the different paper properties, possibly with the exception of their strength properties, where higher amounts of clay act to lower the paper strength.

[0088] The paper produced from stock that included the inventive pulp had from marginally improved to clearly improved properties with respect to roughness, oil absorption and porosity in comparison with the paper produced from a conventional stock.

[0089] With regard to the strength properties of the novel paper in comparison with the strength properties of the conventional paper, the tensile strengths are the same whereas the tear strength of the novel paper is slightly worse than the tear strength of the conventional paper. In this regard, it shall be remembered that the amount of reinforcement fibres in the form of bleached pine kraft pulp fibres in the novel paper is only half the amount of reinforcement fibres in the conventional paper. It will also be noted that beating of the pine kraft pulp was not optimal from a strength aspect. More specifically, beating of this pulp has not been adapted to take into account that the amount of pine kraft pulp fibres in this paper corresponded to only half of these pulp fibres in the conventional paper.

[0090] Light scattering of the novel paper is not on a proper par with the light scattering of the conventional paper. In this regard, it is important to note that the novel paper contains no groundwood pulp fibres, the primary and closest unique property of which pulp fibres is to exhibit maximum light scattering capacity. The fact that the light scattering ability of the novel paper is only 3.5 units lower than the light scattering ability of the conventional paper is to be considered somewhat surprising.

[0091] The ability to base, e.g. the production of magazine paper on a dominant amount of the comparatively inexpensive bleached TMP produced in accordance with the invention, together with a relatively small amount of expensive pine kraft pulp while achieving paper that has the properties described above is to be considered a clear and significant step forward.

1. A method of producing bleached thermomechanical pulp (TMP) or bleached chemithermomechanical pulp (CTMP), including defibrating finely divided lignocellulosic material, such as wood chips, after pretreatment, and bleaching the resultant pulp in the form of a suspension with bleaching agent that enhances the anionic charge of the pulp fibres, whereafter the pulp suspension is subjected to cleaning treatment and then possibly further treated, for instance bleached, prior to delivering the pulp suspension to a paper machine or converting said suspension to storable pulp, characterised in that the defibration of the lignocellulosic material is carried out with the aid of

a) a refiner that has counter-rotating refining discs while using an extra high temperature (HTDD) with or without an immediate following refining stage; or

b) a refiner that has a single rotating refining disc(s) with a single refining zone or with two parallel refining zones, while using an extra high temperature and extra high speed of rotation of the refining disc(s) (RTS) with or without an immediate following refining stage;

and in that the cleaning treatment comprises first screening the pulp suspension and then hydrocyclone cleaning said suspension, wherewith the reject obtained in respective cleaning processes is treated individually and the treated reject returned to the advancing pulp suspension.

2. A method according to claim 1, characterised in that the bleaching agent, which increases the anionic charge of the pulp fibres, consists of an oxidative bleaching agent, such as per-compound.

3. A method according to claims **1** and **2**, characterised in that the pulp suspension is caused to pass through a refiner after said bleaching treatment.

4. A method according to claim 3, characterised by carrying out said refining process at a high pulp consistency.

5. A method according to claim 3, characterised by carrying out said refining process at a low pulp consistency.

6. A method according to claims **1**-**5**, characterised in that, at the cleaning treatment of the pulp suspension up to 20% of the total amount of the fibre material is rejected by screening and at least 30% of the total amount of fibre material by hydrocyclone cleaning.

7. A method according to claims **1**-**6**, characterised in that the reject obtained when screening the pulp suspension is passed in the form of a screen reject pulp suspension through a refiner at high pulp consistency or at a low pulp consistency, alternatively through two refiners, firstly at a high pulp consistency and thereafter at a low pulp consistency; in that the refined screen reject pulp suspension is, in turn, screened so as to obtain an accept pulp suspension and a reject pulp suspension; and in that at least the obtained accept pulp suspension is fed into the advancing pulp suspension in a position downstream of the screening position and upstream of the hydrocyclone cleaning position.

8. A method according to claim 7, characterised in that the obtained reject pulp suspension is returned to the described reject handling system and subjected to renewed refinement.

9. A method according to claims **1**-**8**, characterised in that the reject obtained in the hydrocyclone cleaning of the pulp suspension is passed in the form of a hydrocyclone cleaning reject pulp suspension through firstly a refiner at high pulp consistency and thereafter through a refiner at low pulp consistency, whereafter the hydrocyclone cleaning reject pulp suspension refined in said two stages is fed to the advancing pulp suspension in a position upstream of the hydrocyclone cleaner position and downstream of the screening position.

10. A method according to claims **1**, **6** and **9**, characterised in that the hydrocyclone cleaning is effected with the aid of a large number of hydrocyclone cleaners which are fully cascade coupled.

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